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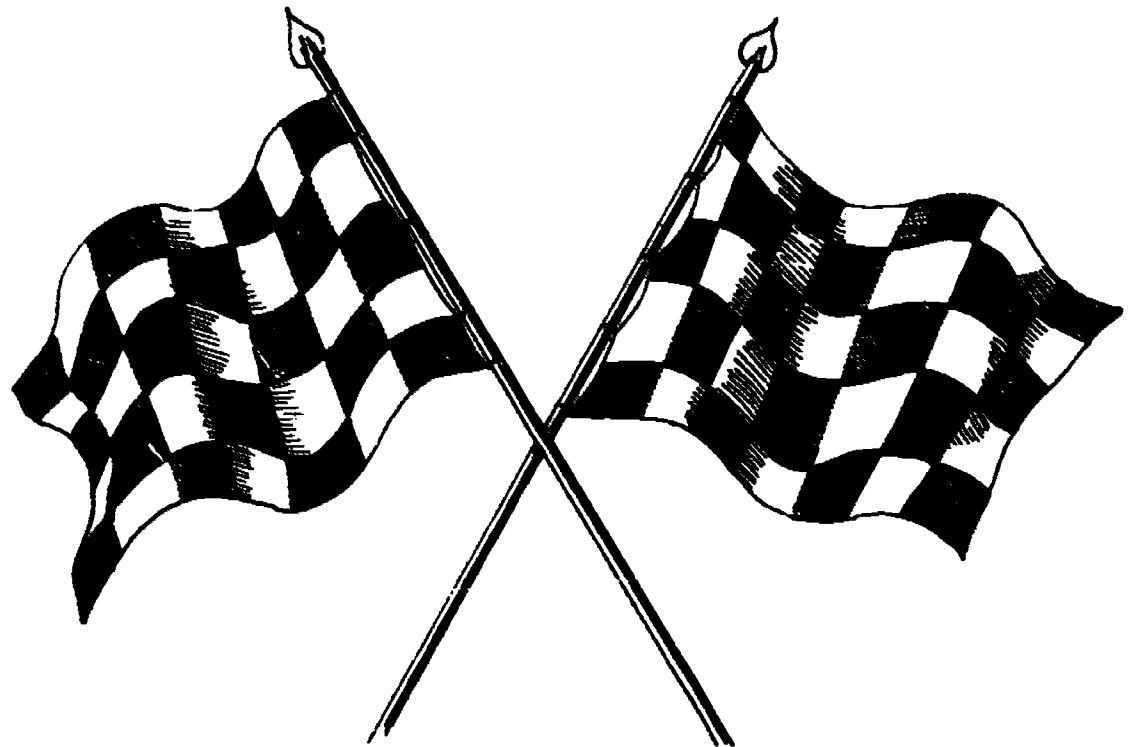
## ABSTRACT

The manual provides industrial arts instructors with information necessary to introduce and teach the metric system to their students. The instructional unit is based on a project, the building of a model automobile racer propelled by a carbon dioxide cartridge. To add interest and enthusiasm, Statewide racing competition in which students may participate is an integral part of the unit. In the instructor's section of the document, metrication is discussed in terms of its effect on teachers, abbreviations, linear measurements, the scale, and four brief exercises. The theory for the model car's propulsion is also explained in that section, and procedures for ordering supplies and equipment and defraying their cost are discussed. Rules and safety regulations for conducting the competition are outlined. Preparing stock for the racer and a conversion table concludes the section. The student section (eight pages) includes three instruction sheets: the first explains necessary terminology, the second gives instructions and specifications needed to design the models, the third is a project plan sheet containing the procedure for building the racer.  
(Author/AG)

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# MISSISSIPPI INDUSTRIAL ARTS

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# -METRIC 500-

## INSTRUCTORS MANUAL

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# **MISSISSIPPI INDUSTRIAL ARTS**

## **-METRIC 500-**

# **INSTRUCTORS MANUAL**

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# INSTRUCTIONS TO THE TEACHER

This packet contains the necessary information for both teacher and students to participate in the Mississippi Industrial Arts METRIC 500.

The manual for the teacher includes the following

- Introduction to the metric system
- Metric abbreviations and prefixes
- Metric linear measurements
- Propelling the METRIC 500 racer
- Material ordering instructions
- Job sheet **Preparing Stock for the METRIC 500 Racer**
- Contest rules and regulations
- Copies of student handout materials

For student use, multiple copies of three instruction sheets are included in this packet. The first is an information sheet explaining terminology students must know in designing and constructing model racers. The second is an assignment sheet giving the instructions and specifications needed to design the models. Third and last is a project plan sheet containing the step-by-step procedure for building the racer.

## **Purpose**

The purpose of this manual is to provide industrial arts instructors with information necessary to introduce and teach the metric system to their students. Traditionally, in industrial arts the project method has been used as the vehicle around which to build the instructional program. This manual follows that established approach.

The project around which this instructional unit is based is a model automobile racer propelled by a CO<sub>2</sub> cartridge. To add interest and enthusiasm to the unit, Statewide racing competition in which students may participate is an integral part.

No attempt is made in this manual to provide the information needed to instruct students on the use of tools, techniques or finishing procedures necessary to construct this project. As industrial arts teachers, you will recognize the need for such instruction and possess the expertise necessary to teach these skills and provide this information.

This manual is primarily concerned with providing help in the form of information necessary to teach students how to measure linear distances in metrics. They must know how to read and use the metric scale in order to design and construct their model racers. Since the racers are propelled by jet propulsion, information is included about this source of power.

# INTRODUCTION

Here is a project ideal borrowed from the IACP-Land Speed Record Assault Vehicle that should be popular with students. This project provides students with a challenge in both design and workmanship and should develop a spirit of friendly competition.

The project is a model of an automobile racer called the METRIC 500. Made of softwood with plastic wheels, the model is propelled by a CO<sub>2</sub> cartridge. Because of the method used to fire the cartridge and the guidance system used in controlling the model, it is extremely important that the specifications and instructions be followed exactly.

After the students complete their models, competitive races may be held to determine the school champion. School champions then may advance to one of the four district semi-final races to be held in early December, coinciding with the Industrial Arts Teachers After-School Workshops sponsored by the State Division of Vocational and Technical Education. Finally, the four district winners will advance to the State finals at the annual Industrial Arts Clinic held in March on the Mississippi State University campus.

Although designing and constructing the model racers are laboratory activities, there is classroom work, outside study, and research involved with the project. For example, what is the current land speed record, when was it set, where, by whom, and in what type of vehicle? How can the timed speed runs be computed into actual kilometers per hour performance? How much thrust is being generated as the model speeds through its run? Why are the automotive and related industries so interested in racing? The teacher should spend periods in the classroom on these and other related topics.

Since the METRIC 500 model racer is propelled by a CO<sub>2</sub> cartridge, a type of jet propulsion, a teaching unit on this topic is included in the manual. This information on power technology should provide additional value and student interest to the project. All dimensions appearing in the instructions for students are given in metrics.

The Ohio State University Research Foundation, **The World of Manufacturing, Industrial Arts Curriculum Project**, Laboratory Manual (Bloomington, Illinois: McKnight & McKnight Publishing Company, 1971), pp. 49-82.)

# METRICATION

The word "metrication" denotes the process of changing from the English weights and measurements system to the metric system. Metrication is in current use across the nation.

The United States is the only major country today which does not use metrics as the standard for weights and measurement. Because of modern means of travel, and as countries depend more on imports and exports, a single standard for weights and measurements is needed throughout the world. This standard will be the metric system. The United States, therefore, is in the process of changing to the metric system.

Some industries in the United States, such as the drug and film industries have been using the metric system for many years. Other industries are in the process of changing to metrics. Several states have recently passed laws requiring schools to teach metric education.

## How the Change Will Affect Teachers

How will this change to the metric system affect teachers? Each industrial arts teacher will need to learn a new system of weights and measurements—the metric system. The present system of English weights and measurements will be replaced by the metric system. Millimeters, centimeters, meters, and kilometers will be used for linear measurements. The milligram, gram, and kilogram will be used to measure weights, and the milliliter and liter will be used to measure liquids.

## A Simpler Method

The metric system will make measuring and using measurements easier than the methods now used in the United States. Here are a few basic principles of the metric system which should be remembered:

1. All the divisions of the basic units, or prefixes, are the same regardless of what you might be measuring. Although distance is measured in meters, weight in grams, and liquid in liters, the prefixes of these measurements are the same. These prefixes are:

kilo	1000 units
hecto	100 units
deka	10 units
deci	0.1 unit (one-tenth of the unit)
centi	0.01 unit (one-hundredth of the unit)
milli	0.001 unit (one-thousandth of the unit)

The most commonly used prefixes are **kilo**, **centi**, and **milli**.

Examples to show students that the same prefixes are used for different types of measurements would be

A weight measurement    9 milligrams    nine-thousandths of a gram  
 A distance measurement    9 millimeters    nine-thousandths of a meter  
 A liquid measurement    9 milliliters    nine-thousandths of a liter

2 Metric weights and measurements are based on the decimal system. This should make the metric system easier to teach and use because there are no fractions or mixed numbers. Two simple math problems may help point out this advantage to students.

#### Problem Number One

Using three pieces of masking tape of the following English measurement lengths:  $4 \frac{1}{8}$ ",  $7 \frac{9}{16}$ ", and  $2 \frac{3}{4}$ ", determine the total length of tape.

#### Problem Number Two:

Using three pieces of masking tape of the following lengths: 85 mm, 19.4 cm, and 57 mm, determine the total length of tape.

Solving problem number one requires four steps.

Step 1. Find the least common demoninator (16).  
 This must be done because unequal fractions cannot be added.

Step 2. Convert all fractions to the least common denominator.

Step 3. Add to find the sum.

Step 4. Change the sum to nearest whole number.

$$\begin{array}{rcl} 4 \frac{1}{8} & = & 4 \frac{2}{16} \\ 7 \frac{9}{16} & = & 7 \frac{9}{16} \\ 2 \frac{3}{4} & = & 2 \frac{12}{16} \\ \hline & & 13 \frac{23}{16} \\ & & 14 \frac{7}{16} \end{array}$$

Number two presents somewhat the same problem because millimeters and centimeters cannot be added. The conversion to all millimeters or all centimeters, however, is very easy because of the decimal system. The problem can be solved in only two steps.

Step 1. Convert to all millimeters or all centimeters.

Step 2. Add to find sum.

$$\begin{array}{rcl} 85 \text{ mm} & = & 85 \text{ mm} \\ 19.4 \text{ cm} & = & 194 \text{ mm} \\ 57 \text{ mm} & = & 57 \text{ mm} \\ \hline & & 336 \text{ mm} \end{array} \quad \text{OR} \quad \begin{array}{rcl} 8.5 \text{ cm} \\ 19.4 \text{ cm} \\ 5.7 \text{ cm} \\ \hline 33.6 \text{ cm} \end{array}$$

336 thousandths of a meter is the same as 33.6 hundredths of a meter.

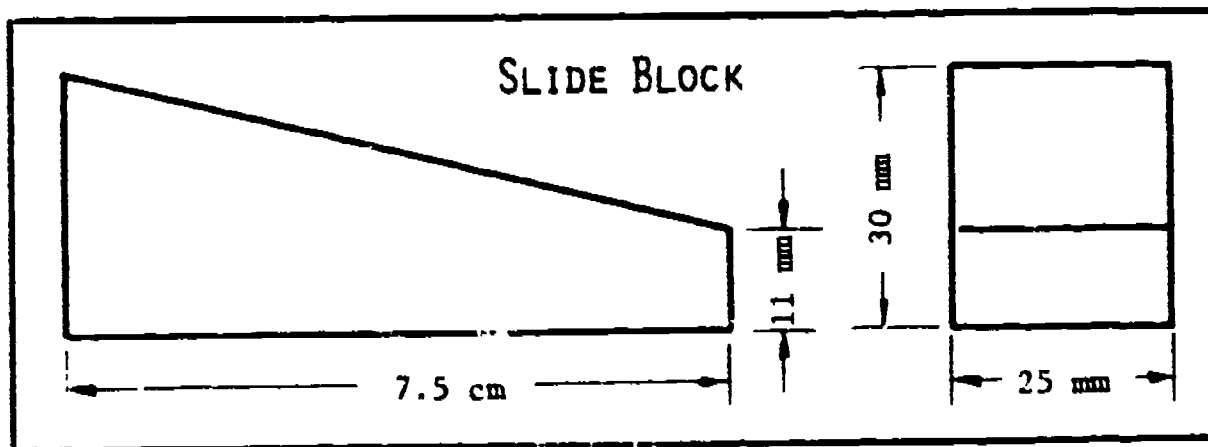
#### Metric Abbreviations

Drawings are of little value unless they contain dimensions. Since it would be time consuming for the draftsman and would take too much space to print the words "inches" or "feet" after each dimension, symbols are used instead. In the English system of measurement the symbol for inches is "in.", and ' is used for feet.

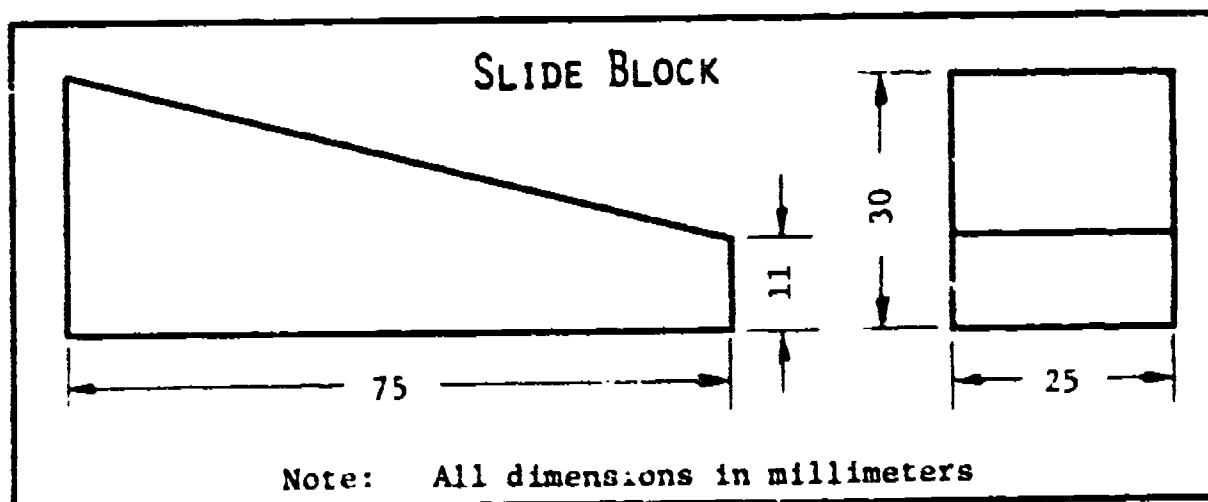
In the metric system of measurements, the words are even longer, therefore, abbreviations are used throughout. The basic unit for length, the meter, is abbreviated by using the small m. Abbreviations for metric linear measurements are:

mm millimeter one-thousandth of a meter  
 cm centimeter one-hundredth of a meter  
 km kilometer one thousand meters

In most drawings millimeters or centimeters are used. All rules of dimensioning are the same. A dimensioned drawing would appear as shown below.



If all of the dimensions on a drawing are in the same unit (for example, all are in millimeters), then a notation to that effect can be made on the drawings. When this is done, all abbreviations following the number are omitted. Such a dimensioned drawing would appear as follows:



## **Metric Linear Measurements**

The metric linear scale is a ruler marked in millimeters rather than inches. It is used to measure distances. To measure with a metric scale, two things will be needed. The first is a metric scale. The second is an activity to give the students an opportunity to use this scale until they become proficient in its use, hence, the project of the model racer. The length of the metric scale should be 305 mm, or a 12 inch ruler which is graduated (marked off) in both inches and millimeters. (305 mm = 12 inches)

### **How the Scale Is Graduated**

Metric linear scales are graduated into millimeters which are not numbered. The numbers appearing on the scale (1 through 30) indicate centimeters. Each centimeter contains 10 millimeters. It is, therefore, easy to convert centimeters into millimeters by adding a zero to the number appearing on the scale. A few examples are as follows

9 centimeters    90 millimeters  
12 centimeters    120 millimeters  
23 centimeters    230 millimeters

### **Measuring with the Scale**

To cut a piece of wood to a length of 273 mm requires marking the length, drawing a line at the mark, and making the cut. Place the end of the scale against the end of the board you are going to cut. Locate the 27 cm line (which is the same as 270 mm), add three millimeters, make a mark at the point of cut, and draw a line through this mark with a square before cutting. (27 cm plus 3 mm = 273 mm)

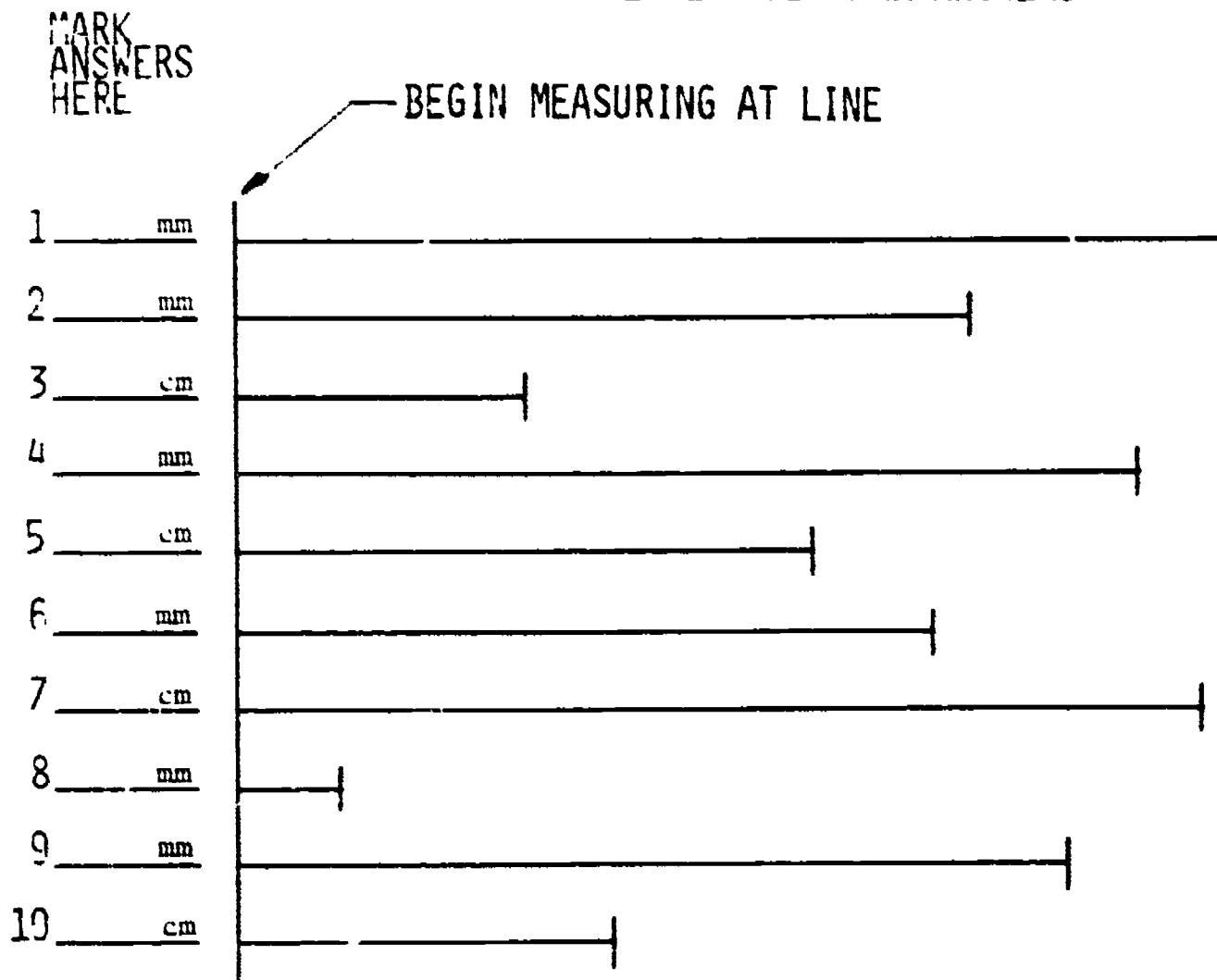
To cut a length of copper tubing 33.5 mm, find the mid-point between 33 mm and 34 mm. Place the end of the scale against the end of the copper tubing, make a mark at 33.5 mm, and make the cut.

### **Exercises**

After explaining the above information to students, let them measure some specified objects. Following are some exercises requiring little or no preparation.

1. What is the length and width in millimeters of their textbook?
2. Measure other objects: piece of chalk, paper, pencil, book, and eraser.
3. Select several rectangular shaped pieces of wood and number them. Have the students measure each piece of wood, and record the number of the piece, its length, width, and thickness on a piece of paper. Compare their answers with the correct measurement. After these exercises, determine if they understand and can measure correctly, or if additional instruction is required.
4. A more formal type test is shown on the following page.

## MEASURE LINES AND MARK ANSWERS



Note: This type of test is easy to prepare on either a ditto or mimeograph stencil. Requiring the answers to be placed on the left side of the page allows fast scoring with a master key.

### Sources of Additional Information

Listed below are several references from which additional information can be secured concerning the metric system.

"Metric System." **The World Book Encyclopedia**. 1971. Vol. XII. pp. 360-363.

"Weights and Measures." **The World Book Encyclopedia**. 1971. Vol. XX. pp. 150-155.

**Man/Society/Technology**, September /October, 1974.

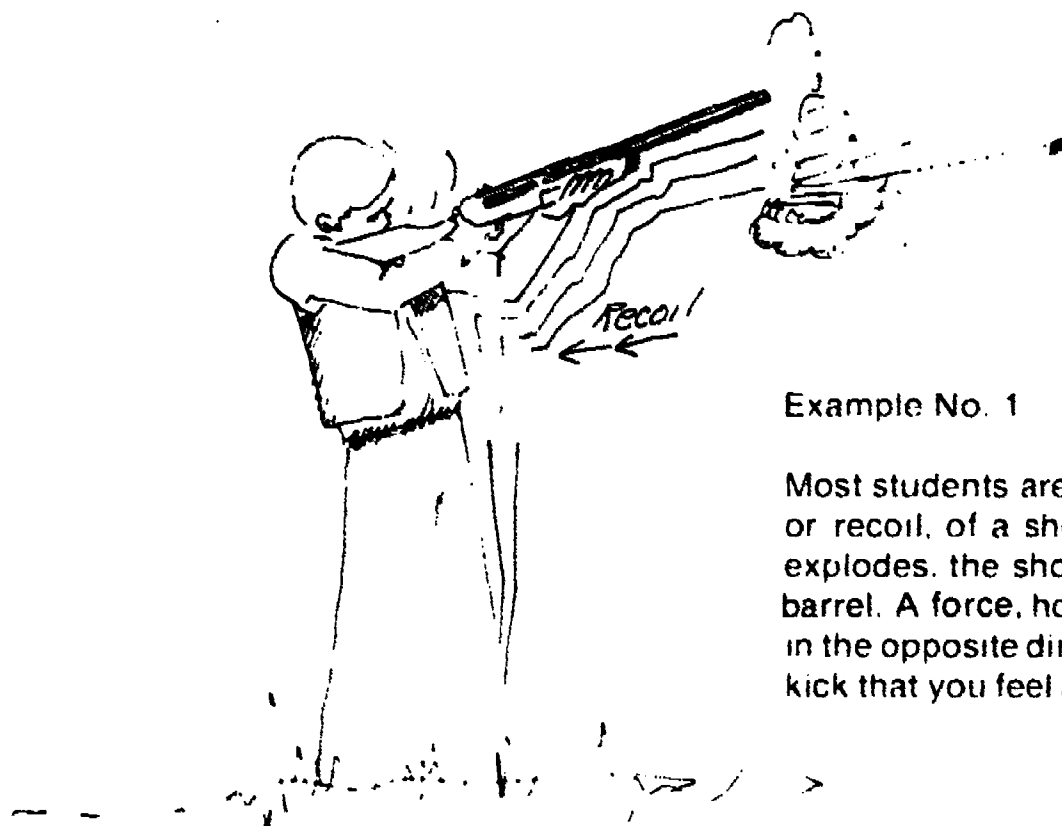
**School Shop**, April, 1974. (Special Issue).

# PROPELLING THE METRIC 500 RACER

The METRIC 500 model racer is propelled by a CO<sub>2</sub> (carbon dioxide) cartridge. It is fired by a mechanical starter which will puncture a small hole in the nozzle of the cartridge. The hole allows the CO<sub>2</sub> gas to escape, or exhaust, to the rear of the vehicle with a large amount of force. The rearward force will cause another force to be created in the opposite direction. This force will push the racer in a forward direction at high speed. This force is called **thrust** and is a principle of jet propulsion. It can be understood by using Newton's laws of motion.

## Newton's Third Law of Motion

Sir Issac Newton, a great 17th Century English scientist, proclaimed three laws that govern the action of motion. It is Newton's third law which explains the basis for jet propulsion. The law is as follows: For every action there is an equal and opposite reaction. Two examples can help explain this law of motion.

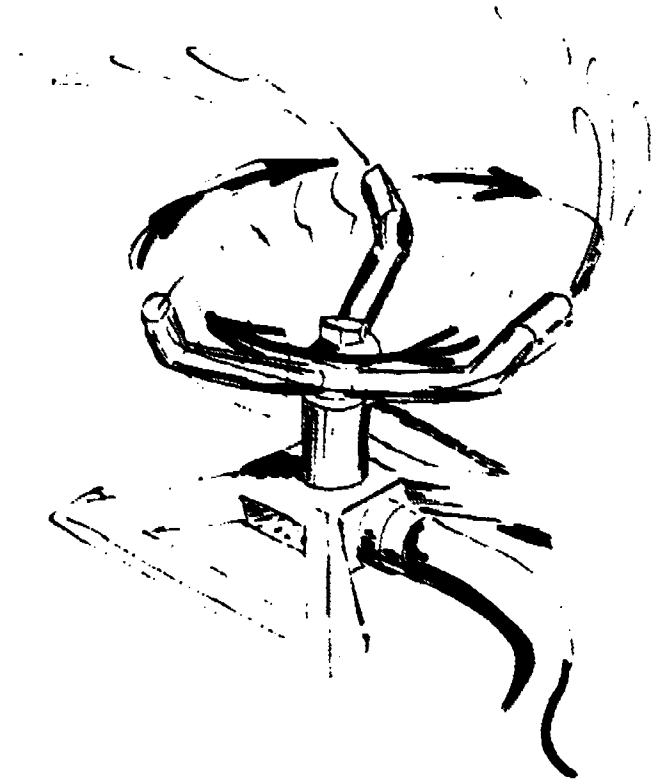


Example No. 1

Most students are familiar with the kick, or recoil, of a shotgun. As the powder explodes, the shot is pushed out of the barrel. A force, however, is also created in the opposite direction, resulting in the kick that you feel against your shoulder.

**Example No. 2**

Most students will also be familiar with rotating lawn sprinklers that spin when water squirts from the nozzles. Such sprinklers may have two, three, or four arms. Rotation occurs when the water is forced out of the nozzle. The arms are pushed around in the opposite direction, causing a spray over the lawn.



**Jet Propulsion**

Jet propulsion is very important in today's world. Most military and commercial airplanes are powered by jet engines. Space ships which have made it possible for man to travel to the moon are powered by rocket engines. Both jet and rocket engines operate on the principle of jet propulsion. This same principle will propel the Metric 500 racer.

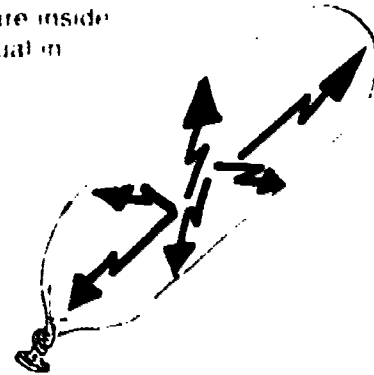
The simplest example of jet propulsion is the toy balloon. Using a balloon, give a demonstration to the class explaining the following information.

The action and reaction that causes the balloon to dart across the room is identical to that which takes place within a jet or rocket engine powered craft. All three, the toy balloon, the jet plane, and the rocket space ship, operate on the principle of Newton's third law of motion. All are forms of jet propulsion.

A. Blow up a balloon. Hold the end tight so the air cannot escape.



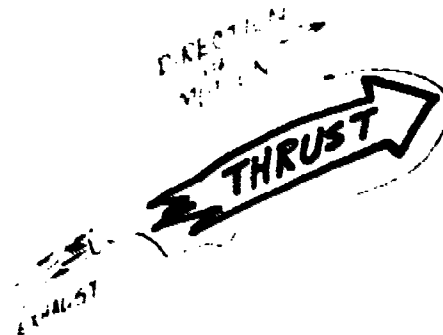
B. The air pressure inside the balloon is equal in all directions.



C. Let go, and the balloon darts wild and fast in one direction. Why does this happen?



D. The air pressure escaping from the rear creates a force on the inside front of the balloon. This force is called thrust and propels the balloon forward.



Many people mistakenly believe the forward movement of a jet airplane or rocket craft is caused by the exhaust pushing against the air at the rear of the vehicle. This belief is not true. The principle of jet propulsion works just as well in a vacuum where no air is present. However, since the jet engine takes in the oxygen needed to burn its fuel from the outside air, it cannot operate at altitudes which contain no air. The rocket engine is not troubled at such altitudes because it carries its own supply of oxygen to burn with its rocket fuel.

Both types of engines are jet propelled. Just like the toy balloon, as a force is built up to the rear by the exhaust, an equal and opposite reaction, called thrust, pushes the jet airplane or rocket craft forward.

## **Sources of Additional Information**

Listed below are references from which additional information can be secured concerning the principle of jet propulsion.

Glenn Harold T. **Exploring Power Mechanics**. 2nd ed. Peoria, Illinois: Chas A. Bennett Company, Inc. 1967. pp. 28-32.

Goodwin, Harold L. "Space Travel." **The World Book Encyclopedia**. 1971. Vol. XVII. pp. 560-573.

Groneman, C. H. and Feirer, J.L. **General Shop**. 3rd ed. New York: McGraw-Hill Book Company. 1963. pp. 288-290.

"Jet Propulsion." **The World Book Encyclopedia**. 1971. Vol. XI. pp. 88-93.

"Rocket." **The World Book Encyclopedia**. 1971. Vol. XVI. pp. 356-361.

# ORDERING SUPPLIES AND EQUIPMENT

The following list contains the supplies and equipment required for building and racing the METRIC 500 racer.

## Supplies Which Can Be Obtained Locally

Wood for racer bodies  
Coat hanger wire for axles  
Finishing supplies  
Decals (optional)  
Screw Eye #6 1" long (2 req. for each model)

Note: May be ordered below if not available locally

## Supplies and Equipment to Be Ordered from

McKnight Publishing Company  
Box 854  
Bloomington, Illinois 61701

Item Number	Description	Cost
B04-6508	Start-Finish Gate Set	\$31.40
T35-6744	Plastic Wheels (pkg. 100)	5.25
T36-6745	CO <sub>2</sub> Cartridge (pkg. 30)	7.80
T07-6716	Screw Eye, #6, 1" long (pkg. 30)	1.50
T33-6742	Washers, Brass #6, (pkg. 100)	1.60

# **DEFRAYING COST OF SUPPLIES AND EQUIPMENT**

Several possibilities exist for defraying the cost of the supplies and equipment required to participate in the METRIC 500. If budget permits, order the supplies and equipment following regular purchasing procedures. As supplies are consumed, charge students for them—as with any other industrial arts project.

If this procedure is not possible, two alternate solutions are offered. First, estimate the total cost required and divide this figure by the number of students who will participate. Collect this amount from the students and purchase the supplies and equipment.

A second alternate solution is to seek local sponsorship for this event. Automobile dealers, automotive parts stores, banks or local merchants may donate (tax deductible) the necessary funds. Try particularly to get someone to donate the money for the start-finish gate which is needed to conduct the local competition. This equipment represents the biggest single expense; however, it can be used year after year.

In seeking sponsorship for the METRIC 500, explain that this is a Statewide competition, that hopefully will develop into an annual affair, and that you want your students to have the opportunity to participate. Sponsors must be acknowledged in some way. In addition to a letter of thanks, perhaps an article telling of their donation could be placed in the school or local newspaper. Sponsors should also be invited to observe the local competition races.

# CONDUCTING LOCAL COMPETITION

The industrial arts instructor shall be in charge of all METRIC 500 competition within the local school. He may ask one or several individuals to assist during the competition.

## Rules and Regulations

The following rules and regulations should be strictly enforced:

1. All contestants must be currently enrolled in an industrial arts course in the school.
2. Contestants whose models are not within the specifications as described in the assignment sheet, **DESIGNING YOUR METRIC 500 RACER**, will be disqualified.
3. Contestants will race their models in pairs with losers being eliminated. Races will continue until all but one contestant has been eliminated. The remaining contestant is to be declared the local school champion.
4. Length of races is to be 15 meters (Distance between start gate and finish gate).
5. CO<sub>2</sub> cartridges are to be handed to contestants at the start gate immediately prior to each race.
6. In the event of a misfire or obvious delayed starting of one model, the race will not be counted and will be repeated.

## Safety Precautions

Before each race, check to make sure that the following safety precautions have been taken:

1. Is the tract free of all objects—including spectators?
2. Are tether lines securely fastened to the starting gate and finishing gate?
3. Are tether lines tight?
4. Are firing pins on firing mechanism adjusted to assure equal penetration?

b. Check model racers on the following

- a. Are wheels securely fastened to model?
- b. Are tether hooks fastened to tether line?
- c. Are CO<sub>2</sub> cartridges fully inserted into engine housing?
- d. Are all models backed up to the start gate? (Nozzles of CO<sub>2</sub> cartridges fit into tubing on start gate.)

**METRIC 500  
PROJECT SHEET No. 1**

**PREPARING STOCK  
FOR THE METRIC 500 RACER**

Each student will need one piece of wood to construct his model racer. This material is cut to the following dimensions from a piece of 51 mm x 101.5 mm lumber (White Pine, Cypress, or Redwood preferred) (Fig. 1)

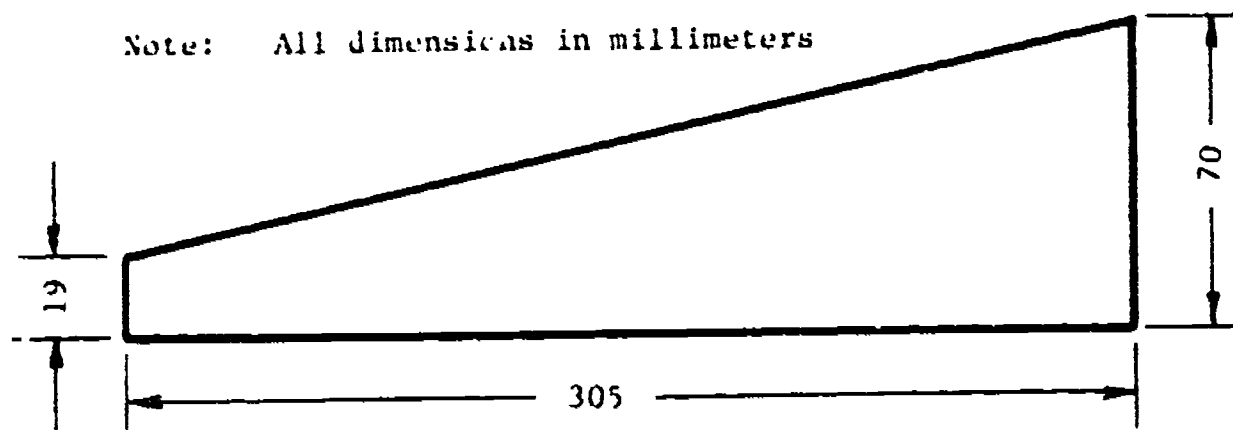
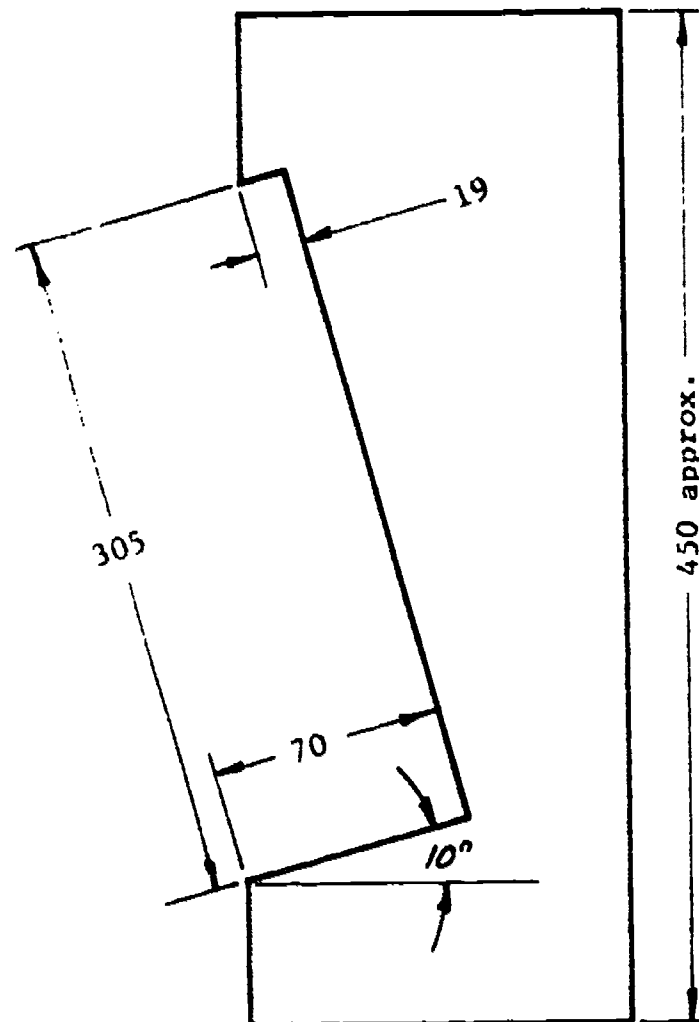


Fig. 1

PREPARING STOCK (cont'd)

A jig can be constructed to aid in cutting the taper. It also has the advantage of allowing one to cut the stock required for two models from one linear foot of 51 mm x 101.5 mm wood. The jig is made from scrap material such as a 51 mm x 153 mm or 51 mm x 202 mm. Be sure the edge which will ride against the rip fence is straight. (Fig. 2)



Note: All dimensions in millimeters

Fig. 2

PREPARING STOCK (cont'd)

1. Cut 51 mm x 101.5 mm x 243.8 cm into 305 mm lengths
2. Place cut 51 mm x 101.5 mm in jig and position upper left corner of jig so it just touches the blade on the table saw. Move rip fence so it touches the right side of jig. Make cut (Fig. 3)

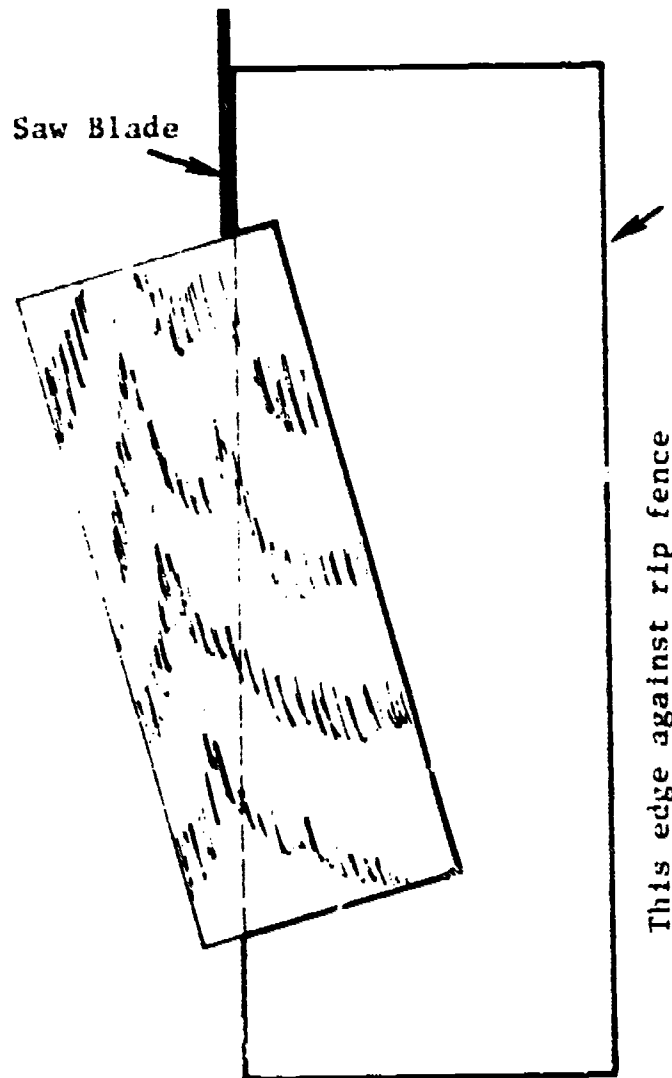


Fig. 3

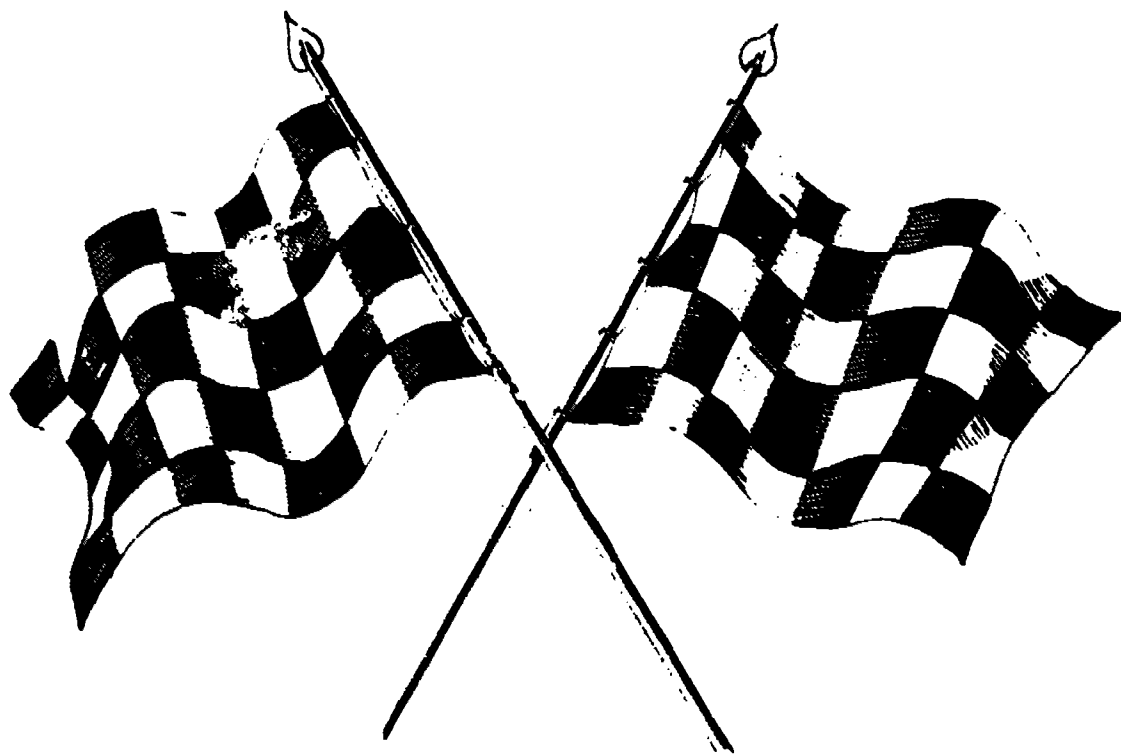
# CONVERSION TABLE

All dimensions and references to size or speeds are presented in the publication using the metric system of weights and measurements. In converting from the English system to the metric system, or vice versa, some "rounding off" accrued. For easy reference, the table is grouped according to the page on which the measurements appear

	<b>METRIC SYSTEM</b>	<b>ENGLISH SYSTEM</b>
Page 14	15 m	49' 3"
Page 16	19 mm	3/4"
	70 mm	2 3/4"
	305 mm	12"
	51 mm x 101.5 mm	2" x 4"
Page 17	51 mm x 153 mm	2" x 6"
	51 mm x 202 mm	2" x 8"
	450 APPROX.	18" APPROX.
Page 18	51 mm x 101.5 mm x 243.8 cm	2" x 4" x 8'
Page 2	24.14 kmph	15 mph
	321.86 kmph	200 mph
	966.55 kmph	600.6 mph
	1158.70 kmph	720 mph
	A3 drawing paper (297 mm x 420 mm)	11" x 17" drawing paper
Page 3	10 mm	3/8"
	13 mm	1/2"
	33 mm	1 1/4"
	42 mm	1 5/8"
	155 mm	6 1/8"
	230 mm	9 1/16"
	270 mm	10 5/8"
	295 mm	11 9/16"
	19 DR x 51 DP	3/4" Drill x 2" Deep
Page 5	3.175 mm	use 1/8" drill
	19 mm	use 3/4" drill

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# MISSISSIPPI INDUSTRIAL ARTS



# -METRIC 500-

STUDENT  
MATERIAL

# **MISSISSIPPI INDUSTRIAL ARTS**

## **-METRIC 500-**

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# METRIC 500 INFORMATION SHEET No. 1

## AUTOMOTIVE TERMS

You must know the meaning of the following words: wheelbase, ground clearance, overall length, axle, and propulsion system. These words are part of the terminology used in automotive engineering and racing.

In building a METRIC 500 model racer, one needs to know this terminology to understand the instructions for its design and construction. Study each definition and illustration until you know the meaning of each term.

**GROUND CLEARANCE** - the distance between the lowest part of the vehicle body and the ground



**MINIMUM** - the lowest limit allowable

**MAXIMUM** - the upper limit allowable

**AXLE** - a pin or shaft on or with which a wheel or wheels revolves



**RESISTANCE** - an opposing or retarding force

**kmph** - an abbreviation for kilometers per hour



**OVERALL WIDTH** - the width of the vehicle from side to side

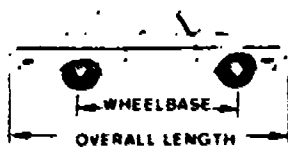
**THRUST WASHER** - Brass washer inserted on axle between wheel and body

**OVERALL HEIGHT** - the distance from the ground to the top of an automotive vehicle

**SPECIFICATION** - a detailed and exact statement prescribing materials, dimensions, and workmanship for something to be built

**TETHER LINE** - Line between start and finish gates used to guide models in straight line of travel. (Use 40 lb. test fishing line.)

**PROPULSION SYSTEM** - the source of power used to propel a vehicle



**WHEELBASE** - the distance between the front and rear axles of an automotive vehicle

**OVERALL LENGTH** - the distance from the front to the rear of an automotive vehicle

**TETHER HOOKS** - screw eyes attached to the underside of the vehicle to control the forward movement along the tether line.

### Note:

When designing and constructing your racer, refer to this information sheet if unsure of any terms used in the instructions.

# **METRIC 500 ASSIGNMENT SHEET No. 1**

## **DESIGNING YOUR METRIC 500 RACER**

Racing has fascinated people since the day the automobile was invented. The first automobile race took place in 1894 with the winner averaging about 24.14 kmph. Today's speeds have increased. Each year, millions of people all over the world watch as race cars whip around the track at speeds close to 321.86 kmph.

The present world speed record for a race car was set in 1965. Craig Breedlove drove his jet-powered SPIRIT OF AMERICA-SONIC I at 966.55 kmph on the Bonneville Salt Flats in Utah. Records, however, are made to be broken. Several racers are being built in an attempt to break the sound barrier on land. To do this they will have to do better than 1158.7 kmph.

This project is a model of a race car. Perhaps this model may be similar in design to one that someday may travel twice the speed of sound. In designing the model there are certain requirements which must be met. These requirements are necessary so that all models constructed can be fired from the same starting gate and make use of the same guidance control system.

The position of the propulsion system must be identical on all models. Ground clearance, as well as overall width of the vehicle at axle positions, must be identical. Other dimensions vary as outlined in the specifications. The design of the vehicle body is up to each student's imagination. Be sure, however, that the model is within the specifications described. You will want to study these specifications carefully before starting the design work.

It may be helpful to do some research before beginning design work. The school library is a good place to start. In addition to encyclopedias, look at magazines such as **Mechanics Illustrated**, **Hot Rod**, and **Car and Driver**. Rather than searching for a design to copy, look for outstanding features of several designs which might be incorporated into a sure winner. But remember, the design must be kept within the specifications described.

### **Equipment and Supplies Needed**

Metric rule, A3 drawing paper (297 mm x 420 mm), pencil, scrap paper, drawing board, T-square, angles, and French curve.

## Specifications

The body of the model must be of one-piece wood construction. No additional parts, such as fenders, plastic canopy, or air-foils can be attached to the model. Windshields or canopies may be painted on, however, during the finishing process. A minimum of 3 mm thickness around CO<sub>2</sub> cartridge must be maintained for safety. The model must have four 41 mm diameter plastic wheels with axles enclosed.

### OVERALL LENGTH

295 mm maximum—195 mm minimum

### WIDTH AT AXLE POSITIONS (FRONT AND REAR)

42 mm

### HEIGHT OF BODY

70 mm maximum— 48 mm minimum at rear of vehicle

### WHEELBASE

270 mm maximum—105 mm minimum

### GROUND CLEARANCE

13 mm

### TETHER HOOKS

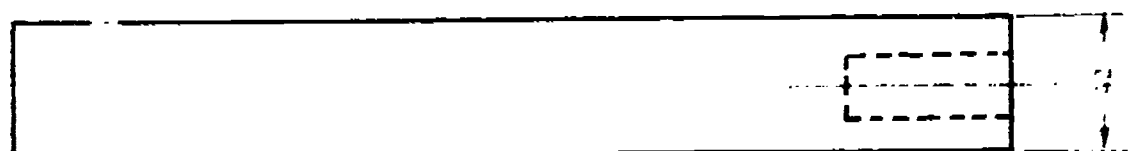
No. 6 screw eye on C/L of bottom - minimum distance apart 155 mm

### PROPULSION SYSTEM LOCATION

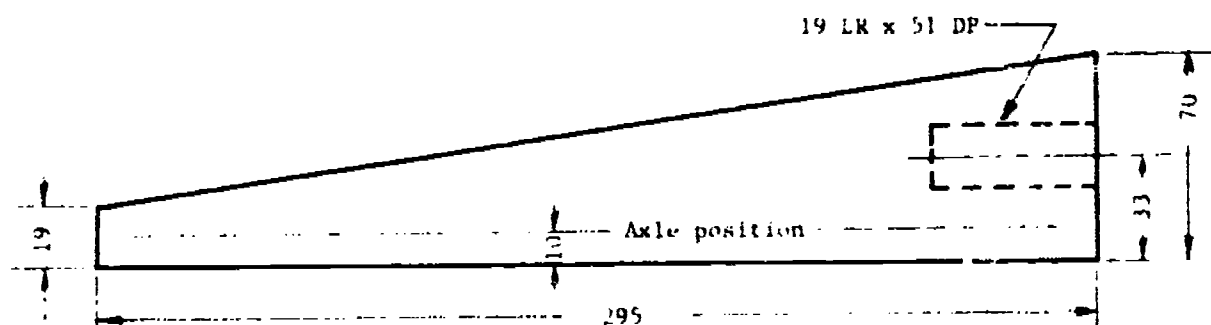
33 mm from bottom of vehicle on C/L

**Procedure:** Check off each step as completed

- \_\_\_\_ 1. Fasten drawing paper to board
- \_\_\_\_ 2. Draw top and front view of basic requirements of the METRIC 500 racer to dimensions shown on drawing.



Note: All dimensions in millimeters, maximum length, height, and width are shown.



- \_\_\_\_ 3. Sketch several designs for the body of your racer on scrap paper.
- \_\_\_\_ 4. Select the best design idea and carefully draw it on the top and front view of the basic drawing. This step will complete the drawing.

## DESIGNING YOUR METRIC 500 RACER (cont'd)

- \_\_\_\_ 5. If colored pencils are available, color your completed drawings.
- \_\_\_\_ 6. Apply test of workmanship and make corrections required.
- \_\_\_\_ 7. Cut out the top and front views using scissors. These cutouts will be used for patterns when building the model.

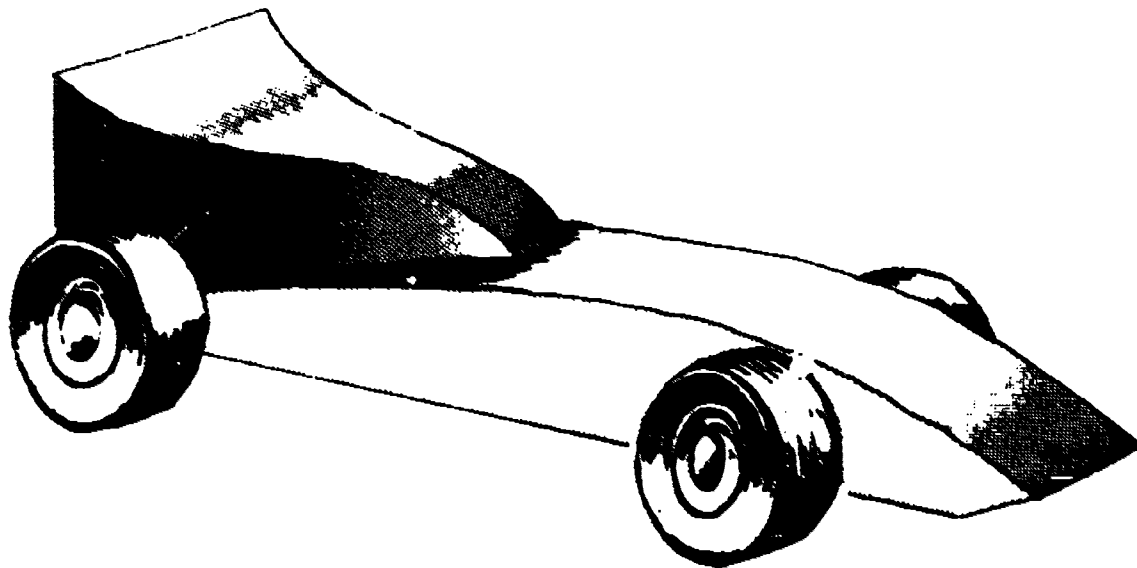
**Test of Workmanship:** When the design is completed, test the workmanship on the following points before cutting out the patterns.

1. Are the measurements on the drawing the same as the dimensions appearing in Step 2 of this instruction sheet?
2. Check to be sure that the drawing does not go above or below the maximum or minimum specifications outlined in this instruction sheet.
3. Check the axle position and the propulsion system location carefully. These are critical measurements.
4. Look at the top view drawing. Are both sides symmetrical (alike)?
5. Look at the front view drawing and consider the following points: wind resistance, drag, streamlining, general appearance.

## METRIC 500 PROJECT SHEET No. 2

### BUILDING THE METRIC 500 RACER

Here is a chance to build a project that could get you into the State championships. Careful workmanship during construction and finishing could give your model an edge over those being built by your classmates. The model must be constructed to the specifications outlined in the assignment sheet, "DESIGNING YOUR METRIC 500 RACER."



**Procedure:** Check off each step when it is completed.

- ..... 1. Complete a Student Job Plan and have it approved by instructor.
- ..... 2. Secure materials, check and record on Student Lab Card.
- ..... 3. Square bottom edge of stock using a jack plane.
- ..... 4. Square both ends of stock using a block plane.
- ..... 5. \* Locate and drill axle holes. (3.175 mm drill)
- ..... 6. \* Locate center for engine hole. Using a 19 mm bit, bore a hole 51 mm deep.  
(Ask another student to help you with this operation by watching the brace and bit to make sure it is being held straight)
- ..... 7. Trace side view pattern on stock and cut out.
- ..... 8. Trace top view pattern on stock and cut out.

## BUILDING THE METRIC 500 RACER (cont'd)

- \_\_\_\_ 9. Shape body to desired contour.
- \_\_\_\_ 10. Sand body smooth.
- \_\_\_\_ 11. Apply finish as desired. (decals optional)
- \_\_\_\_ 12. Locate and fasten two No. C screw eyes to bottom of model.
- \_\_\_\_ 13. Cut axles (coat hanger wire) to length and file ends if needed.
- \_\_\_\_ 14. Assemble axles, brass washers, and wheels on model.
- \_\_\_\_ 15. Apply test of workmanship and make corrections required.
- \_\_\_\_ 16. Turn in project and Student Job Plan to instructor for grading.

\*Steps 5 and 6 are very important and **must** be exact in order for the racer to line-up with the firing mechanism on the start gate. Recheck these measurements.

### Test of Workmanship

When model is completed, test your workmanship on the following points before submitting it for a grade.

- 1. Are the wheels securely fastened to the axles?
- 2. Does the model sit squarely on a flat surface?
- 3. Is the finish smooth and free of runs?
- 4. Looking directly down on the top of the model, are both sides symmetrical (alike)?
- 5. What improvements would you make in your workmanship if you were to make this same project again?